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ENVIRONMENTAL & PROJECT DEVELOPMENT ASPECTS OF FIRING REFUSE DERIVED FUEL IN A CEMENT KILN

by
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1. Introduction

Disposal of non-hazardous Municipal Solid Waste has become a critical problem, particularly in large urban areas such as the Golden Horseshoe. It is increasingly obvious that the situation can only be brought under control by utilizing all disposal alternatives to some degree: recycling, landfill and energy from waste.

St. Lawrence Cement is presently developing a project to replace up to 20% of the coal used to fire our large cement kilns with Refuse Derived Fuel. This would then significantly reduce the quantity of waste disposed of at the local landfill sites, while at the same time reducing the coal required in the process to produce cement. The burning of this fuel in a cement kiln offers some particularly unique environmental advantages. Because this processing of waste produces a useful product, while at the same time reducing the consumption of a natural resource this process is regarded as a recycling project.

It was St. Lawrence Cement's goal from the outset of this project that the local community be completely involved in the development of the project.

To accomplish this, a unique organization structure for the evaluation of the project was established.

Since the project was originally conceived and the initial discussions were held with the local municipalities, four years have passed. We are now at the stage where we will be submitting our Draft Environmental Assessment Document to the Environmental Assessment Branch.

2. <u>The Cement Manufacturing Process</u>

When we utilize the term Refuse Derived Fuel, essentially we are referring to a fuel that is produced when post recycled solid, non-hazardous waste is processed. The Resource Recovery plant separates the burnable portion of the waste as Refuse Derived Fuel, as well as separating metal, compost and the rejected material to be returned to the landfill site.

St. Lawrence Cement began to study the possibilities of utilizing Refuse Derived Fuel in our kilns due to two main reasons - energy conservation and waste reduction. Energy conservation because cement manufacturing is a large fuel consumer. The cement manufacturing process ranks behind only steel and chemicals as the largest fuel consuming process. In fact, fuel costs comprise approximately 1/3 of our

total manufacturing costs. Waste reduction because both the Regions of Peel and Halton had identified Energy from Waste in some form as a necessary component to solving the regions' solid waste management problems. St. Lawrence Cement felt that we had the best process to co-operate with the regions in this endeavour and it is for that reason that our plant has been identified in the Peel Waste Master plan.

The cement manufacturing process is a relatively simple process. The main component is limestone and that is quarried at Colborne, approximately 150 km east of the plant. The limestone is shipped in a primary crushed state (minus 200 mm) by ship to the manufacturing plant in Mississauga. Approximately 2.5 to 3 million tonnes of limestone are shipped annually since it requires 1.5 tonnes of limestone to produce 1 tonne of cement. The limestone is stockpiled at the back of the plant because the ship does not operate during the winter months. This limestone is then reclaimed as it is required in the process. The limestone, together with small portions of other raw materials such as shale, iron pyrite or sand, (these additives produce the correct chemical composition of the ground raw material mix) are fed to a large ball

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mills where it is ground into a fine powder. At the Mississauga plant, there are two processes, the wet and dry process. In the dry process, the ground limestone remains in the dry state and is called raw meal. In the wet process, approximately 1/3 water is added to the ground raw materials, with that, it becomes a thick permeable material known as slurry. The slurry or raw meal are then stored in special storage silos.

From the storage silos, the raw meal or slurry is fed to either the wet or dry process kilns. The kilns are a continuous process where the material is heated to a final temperature of 1400 deg. C. Essentially, at this temperature, the raw materials are in a semi-molten state and it is here that the chemical reactions occur that give the final cement powder its hydraulic characteristics. The product discharged from the kiln is called clinker and it is a semi-finished product at this state. It is in the kilns where the high fuel consumption occurs and where the Refuse Derived Fuel would be used as a partial fuel replacement. This process offers a number of particularly unique advantages for the burning of Refuse Derived Fuel.

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1. The flame temperatures are exceedingly high 1700 deg - 2100 de C resulting in the destruction of harmful compounds. There is also the safeguard that these temperatures must be maintained to produced a quality product.
2. The retention time at these high temperatures is extremely long 7 - 12 seconds compared to an incinerator where the retention time is one second maximum.
3. There is no ash to dispose of because it becomes part of the product.
4. The limestone feed to the kiln provides a scrubbing action for the exhaust gases.

From the kiln, the semi finished product, clinker, is conveyed to storage. From the storage area, the clinker is fed to large grinding mills where it is ground into a fine powder, together with approximately 5% gypsum. The resulting product is Portland Cement. Cement is not to be confused with concrete. Cement is a gray powder that is shipped in either bulk or bag. Concrete is the ultimate final product that is produced when cement is combined with sand, stone and water. It is concrete that is used for constructing roads, buildings, etc.

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3.0 Environmental Aspects

The first step in the study was to make a detailed environmental analysis of the process in order to fully evaluate the environmental impact of substituting Refuse Derived Fuel for coal in the cement manufacturing process. This study was conducted by the Ontario Research Foundation. The initial study was conducted for only kiln 3, the large precalciner kiln. A new report has recently been issued covering all 3 kilns at the Mississauga plant.

The study was conducted in the following manner. Based on information provided by St. Lawrence Cement and obtained from a number of other sources, a material balance was prepared for current kiln operations when coal alone is used as the fuel. Then, similar material balances were prepared to reflect the use of RDF in the three different combinations to partially replace coal. A comparison of the material balances showed that neither the flowrates nor the composition of the major gaseous components in the stack gases will change significantly with RDF usage. As a result, the dispersion characteristics of the Kiln Stack gases will not change significantly with the RDF program, provided that there are no other operating changes.

Projected emission rates of Kiln Stack components,

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other than the major gaseous components, when the RDF program is implemented were obtained by a review of information from the following sources:

- actual emission tests carried out at Kiln #1, Kiln #3 and the Coal mill during normal plant operations when coal alone is used as the fuel.
- analyses of raw meal, waste iron oxide, coal and RDF samples typical of the material presently used in the kilns or expected to be used in the kilns
- literature survey of coal, RDF and municipal solid waste combustion

These following emission component groups were included in the environmental assessment:

- particulate material
- acid gases
- metals
- inorganic elements
- polychlorinated organics
- polycyclic aromatic hydrocarbons.

From an environmental perspective, these are the components which are generally considered to be the most important in flue gases discharged from coal and RDF combustion.

Emission rates from the Kiln Stack for the components associated with the current use of

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coal as a fuel, the planned use of coal as a fuel, and three RDF options were combined with the results of various dispersion models to derive predicted ground level component concentrations. Half-hour "point-of-impingement" concentrations were derived using the prescribed calculations in Regulation 308 of the Ontario Environmental Protection Act. Models proposed by the MOE to replace the existing models in Regulation 308 were used to calculate maximum 1-hour concentrations. The set of models proposed by the MOE include a lake-breeze model, which predicts maximum 1-hour concentrations of components from a stack situated near a body of water. This model was used to predict the effect of such a lake breeze on the St. Lawrence Kiln Stack. Long-term concentrations (annual) were predicted with the use of the United States Environmental Protection Agency (USEPA) Industrial Source Complex Long Term (ISCLT) model, in an attempt to determine long-term effects of the emissions from the facility.

Predicted concentrations were compared with levels defined in Regulation 308, Regulation 296, the MOE tentative standards, guidelines and provisional guidelines, and the MOE proposed air quality standards.

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Under existing air quality standards and guidelines, the predicted concentrations attributable to the St. Lawrence Kiln Stack are not expected to exceed 9% of any allowable level, with most contaminants expected to be less than 0.1% of allowable levels. Concentrations are not expected to exceed 16% of the MOE's proposed standards, with most contaminants less than 0.1% of these standards.

The detailed information is summarized in table 12 from the Ontario Research Foundation report which is attached to this paper.

4. <u>Development of the Project</u>

The beginning of this project dates back to 1984, when St. Lawrence Cement recognized that the time had arrived to consider replacing a portion of the kiln fuel with Refuse Derived Fuel. The cement kiln has been recognized for a number of years as a superior process for the destruction of waste. Since the Regions of Peel and Halton were both facing serious refuse disposal problems and the fuel requirements of the cement kiln are high, it was realized that a Refuse Derived Fuel study should proceed.

A preliminary feasibility study was made and this showed that such a project was indeed a viable consideration. The environmental study as we have just

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seen showed, as expected, that the burning of Refuse Derived Fuel in the cement kiln was an environmentally sound concept.

Support was indicated from both the Regions of Peel and Halton and the City of Mississauga and the project study started in earnest. Proctor & Redfern were hired as consulting engineers and Turkstra Mazza Munroe as legal counsel.

An organizational structure was established keeping several key considerations in mind.

1. It is necessary to communicate effectively with all groups and jurisdictions openly and completely at all stages, as the project develops.
2. The cement manufacturing process is environmentally superior to all other alternatives and, as such, we should not hesitate to have all aspects of the project evaluated.
3. Communication and involvement in the development of the process is crucial to the acceptance of the project.
4. There will only be one opportunity to proceed with any waste project in the next few years. If the political process is not well done and fails, it will not be possible to institute another waste project in the near future.

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The Organizational Structure that was established to address the political aspects of the project is illustrated in Figure 5. As can be seen, this organizational structure is ultimately responsible to St. Lawrence Cement. Each group has a key function in the development of this project.

Project Steering Committee

This committee is comprised of representatives from the following organizations: St. Lawrence Cement; Holderbank Consulting Ltd.; Ontario Research Foundation; Proctor & Redfern, Consulting Engineers; Turkstra-Mazza, Lawyers; Media Plus, Communications.

The committee develops and reviews the technical information required for the project, as well as the strategy required for the progress of the project. The technical reports that have been prepared and reviewed by the members of this committee to date are the following:

-"St. Lawrence Cement, Inc. Fuel Cost Reduction Study-Study Document No. 1"

-"Technical Feasibility Study of the Use of Refuse Fuel (RDF) by St. Lawrence Cement, Inc."

-"Preliminary Assessment of Air Emissions for the St. Lawrence Cement RDF Study"

-"St. Lawrence Cement Preliminary Planning Report"

-St. Lawrence Cement RDF Plant Transportation Aspects"

-"Haul Route Impact Analysis"

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- an independent, but knowledgeable chairperson
- 3 St. Lawrence Cement representatives
- 3 representatives from the Community Liaison Committee
- 4 municipal staff representatives from the local and regional municipalities.

This group reviews the details of all documentation that is prepared, recommends other studies to be undertaken and reviews all reports that are prepared. They have decision making power and their recommendations with respect to the project will be received and reviewed by the company.

5. Conclusions

The utilization of Refuse Derived Fuel to replace up to 20% of the coal utilized in the manufacture of cement at St. Lawrence Cement's Mississauga plant is viable. This RDF fuel can be produced from the processing of post source separated Non-Hazardous Municipal Solid Waste. This project will significantly reduce the quantity of waste to be landfilled in the Regions of Peel and Halton while at the same time reducing the coal requirements of the St. Lawrence Cement plant. The study results indicate that the cement kiln is an environmentally superior process in which to utilize waste fuels. The involvement of the local community is critical to the successful development of a project such as this.

-"Report on Recycling Programs"

- A number of reports relating to the Assessment of various alternatives for the Fuel Cost Reduction Study following the Environmental Assessment procedure leading to the final report "Description of the Undertaking".

One of the most important strategy aspects of the project that the Steering Committee developed was this organization structure. The committee has developed key areas of the project communication plan which has involved, to date, newspaper press releases, newspaper advertisements, a television news report, radio interviews and a newsletter for the local residents.

Community Liaison Committee

The Community Liaison Committee is comprised of representatives of local citizens groups, the local environmental groups and local citizens who have an interest in the project. The prime function of the group is communications. The committee receives all information with respect to the progress of the project and provides feedback from the community at large. This committee has nominated 3 representatives to sit on the Project Study Group. Approximately 15 to 20 people are present at the meetings.

Project Study Group

This group is charged with the responsibility of producing recommendations with respect to the development of the overall project. It is comprised of:

ABLE 12: Maximum Ambient Concentrations due to
All Operations Compared with Proposed
Ambient Air Quality Standards

ontaminant	Proposed Air Quality Standard (ug/m3)	Averaging Time	CURRENT OPERATIONS COAL ONLY Max Conc (ug/m3)	CURRENT OPERATIONS COAL ONLY Percent of Prop Stds	PLANNED OPERATIONS COAL ONLY Max Conc (ug/m3)	PLANNED OPERATIONS COAL ONLY Percent of Prop Stds	PLANNED OPERATIONS 20% RDF KILN 3 Max Conc (ug/m3)	PLANNED OPERATIONS 20% RDF KILN 3 Percent of Prop Stds
uspended Particulate	120	24-h	18.147	6.202	15.872	5.424	15.372	5.424
	60	1-y	18.147	2.372	15.872	2.074	15.872	2.074
ulphur Dioxide	690	1-h	78.839	11.426	60.681	8.794	60.566	8.778
	275	24-h	78.839	11.757	60.681	9.049	60.566	9.032
	55	1-y	78.839	11.241	60.681	8.652	60.566	8.636
arbon Monoxide	36200	1-h	25.527	0.071	19.769	0.055	24.467	0.068
	15700	8-h	25.527	0.091	19.769	0.070	24.467	0.057
itrogen Dioxide	200	24-h	80.496	16.506	65.551	13.441	61.196	12.548
ydrogen Chloride	40	24-h	2.334	2.393	1.834	1.880	1.834	1.880
ntimony	3	24-h	0.0000008	0.00001	0.000005	0.00008	0.000005	0.00008
rsenic	0	24-h	0.0001	0.020	0.0002	0.023	0.0002	0.023
arium	10	24-h	0.003	0.012	0.003	0.011	0.003	0.011
eryllium	0.01	24-h	0.00002	0.062	0.00002	0.063	0.00001	0.061
oron	35	24-h	0.036	0.042	0.030	0.035	0.030	0.036
admium	2	24-h	0.002	0.043	0.002	0.034	0.002	0.035
alcium	10 (1)	24-h	3.911	16.040	3.939	16.153	3.941	16.160
hromium	2	24-h	0.009	0.257	0.008	0.219	0.009	0.251
opper	50	24-h	0.001	0.001	0.001	0.001	0.001	0.001
Iron	4	24-h	0.231	2.370	0.214	2.197	0.213	2.180
ead	5	24-h	0.091	0.747	0.071	0.583	0.080	0.653
agnesium	100 (2)	24-h	0.168	0.069	0.165	0.068	0.166	0.068
anganese	10	24-h	0.009	0.036	0.008	0.033	0.008	0.033
ercury	2	24-h	0.003	0.068	0.003	0.055	0.004	0.073
ickel	2	24-h	0.009	0.185	0.008	0.155	0.008	0.162
elenium	10	24-h	0.0000008	0.000003	0.0002	0.001	0.0002	0.001
ilver	1	24-h	0.0002	0.010	0.0002	0.008	0.0002	0.008
Tellurium	10	24-h	0.0000008	0.000003	0.00002	0.00006	0.00002	0.00006
Tin	10	24-h	0.004	0.016	0.003	0.014	0.004	0.016
Titanium	35	24-h	0.028	0.033	0.026	0.030	0.027	0.032
Vanadium	2	24-h	0.001	0.014	0.001	0.013	0.001	0.013
Zinc	100	24-h	0.046	0.019	0.036	0.015	0.038	0.015
PCDD	0.00003	1-y	0.00000005	0.015	0.00000005	0.013	0.0000001	0.026
PCDD + PCDF mixtures	0.00003	1-y	0.000000~~2~~1	0.017	0.000000~~2~~1	0.014	0.000000~~2~~1	0.030
Chlorobenzenes	35 (3)	24-h	0.000005	0.000006	0.000005	0.000005	0.00003	0.00004
Chlorophenols	20 (4)	24-h	0.000005	0.00001	0.000004	0.00001	0.00003	0.00007
PCB	0.15	24-h	0.00001	0.004	0.00001	0.003	0.000010	0.003
PAH	0.0011 (5)	24-h	0.0003	10.336	0.0002	9.068	0.0002	7.859

Notes:
(1) as calcium oxide
(2) as magnesium oxide
(3) as trichlorobenzene
(4) as pentachlorophenol
(5) as benzo(a)pyrene

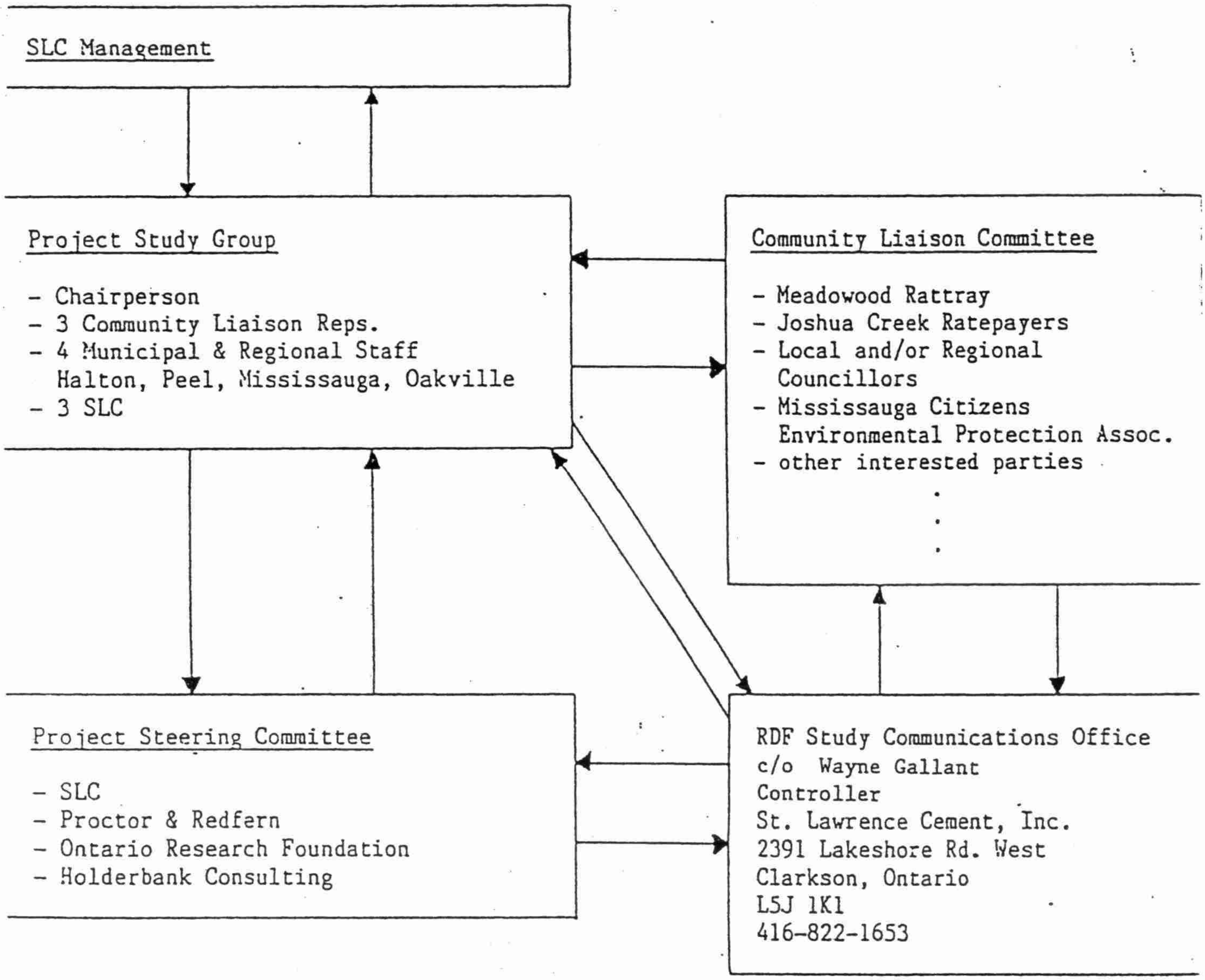
TABLE 12 CONT: Maximum Ambient Concentrations due to All Operations Compared with Proposed Ambient Air Quality Standards

Contaminant	Proposed Air Quality Standard (ug/m3)	Averaging Time	PLANNED OPERATIONS 20% RDF KILNS 1 & 2 10% RDF KILN 3 Max Conc (ug/m3)	Percent of Prop Stds	PLANNED OPERATIONS 20% RDF KILNS 1 & 2 20% RDF KILN 3 Max Conc (ug/m3)	Percent of Prop Stds
Suspended Particulate	120	24-h	15.872	5.424	15.872	5.424
	60	1-y	15.872	2.074	15.872	2.074
Sulphur Dioxide	690	1-h	59.019	8.553	58.962	8.545
	275	24-h	59.019	8.801	58.962	8.793
	55	1-y	59.019	8.415	58.962	8.407
Carbon Monoxide	36200	1-h	22.118	0.061	24.467	0.068
	15700	8-h	22.118	0.079	24.467	0.087
Nitrogen Dioxide	200	24-h	54.492	11.174	52.372	10.739
Hydrogen Chloride	40	24-h	1.948	1.997	1.948	1.997
Antimony	3	24-h	0.000005	0.00008	0.000005	0.00008
Arsenic	0	24-h	0.0002	0.023	0.0002	0.023
Barium	10	24-h	0.003	0.011	0.003	0.011
Beryllium	0.01	24-h	0.00001	0.061	0.00001	0.059
Boron	35	24-h	0.031	0.036	0.031	0.037
Cadmium	2	24-h	0.002	0.035	0.002	0.036
Calcium	10 (1)	24-h	3.940	16.158	3.941	16.163
Chromium	2	24-h	0.009	0.235	0.009	0.251
Copper	50	24-h	0.001	0.001	0.001	0.001
Iron	4	24-h	0.213	2.185	0.213	2.180
Lead	5	24-h	0.081	0.663	0.085	0.696
Magnesium	100 (2)	24-h	0.165	0.068	0.166	0.068
Manganese	10	24-h	0.008	0.033	0.008	0.033
Mercury	2	24-h	0.004	0.079	0.004	0.091
Nickel	2	24-h	0.008	0.159	0.008	0.162
Selenium	10	24-h	0.0002	0.001	0.0002	0.001
Silver	1	24-h	0.0002	0.008	0.0002	0.008
Tellurium	10	24-h	0.00002	0.00006	0.00002	0.00006
Tin	10	24-h	0.004	0.015	0.004	0.016
Titanium	35	24-h	0.027	0.031	0.028	0.032
Vanadium	2	24-h	0.001	0.013	0.001	0.013
Zinc	100	24-h	0.037	0.015	0.038	0.015
PCDD	0.00003	1-y	0.0000001	0.028	0.0000001	0.036
PCDD + PCDF mixtures	0.00003	1-y	0.000000~~3~~1	0.030	0.000000~~2~~1	0.037
Chlorobenzenes	35 (3)	24-h	0.00003	0.00004	0.00005	0.00005
Chlorophenols	20 (4)	24-h	0.00003	0.00007	0.00005	0.00010
PCB	0.15	24-h	0.00001	0.003	0.000009	0.003
PAH	0.0011 (5)	24-h	0.0002	7.868	0.0002	7.263

Notes:
(1) as calcium oxide
(2) as magnesium oxide
(3) as trichlorobenzene
(4) as pentachlorophenol
(5) as benzo(a)pyrene

ST. LAWRENCE CEMENT, INC. REFUSE DERIVED FUEL STUDY

ORGANIZATION STRUCTURE



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